Appendix 5

Supplementary Material for Chapter 5

Part C
Table Comparing Method P (State Method) and the Federal Method (40CFR appendix M) for PM10 Samplers

Appendix C. Comparison of Method P (State Method) and the Federal method (40CFR appendix M) for PM10 samplers.

Parameter	**Method P**	**40CFR part 50 Appendix M**
1.0 Principle		1.1
1.2 Applicability .		1.0
2.0 Range	The lower limit of the mass concentration range is limited by the repeat-ability of filter tare weights, assuming the nominal air sample volume for the sampler. The upper range limit is determined by the point at which the sampler can no longer maintain the required flow. This limit is a complex function of particle type and size distribution which is not readily quantifiable.	3.0 Should measure 24hr PM10 mass concentration of at least 300 ug/m3 while flow rate is within limits For samplers with auto filter changer, No upper limit.
3 Interferences	3.1 Loss of Volatile particles Volatile particles collected on filter material can be lost during shipment and/or storage of the filters. Filters should therefore be reweighed as soon as possible. 3.2 Artifact Particulate Matter, negative error, positive error (alkalinity of filters) Filters that meet the alkalinity specifications (Section 6, paragraph 6.4) show little or no artifact sulfate. Loss of true nitrate is dependent on location and temperature but for most locations the errors are expected to be small**.**	6.1 Volatile particles 6.2 Artifacts, negative and positive error (gas adsorption on PM) 6.3 Humidity 6.4 Filter handling 6.5 Flow rate variation 6.5 Air volume determination
4. 1 Precision	Must be ± 15% of the true value at the 95 percent confidence level (collocated sampler	4.0 Must be 5 ug/m3 for [PM10] below 80 ug/m3, 7 percent for [PM10] above 80 ug./m3 (collocated samplers)
4.2 Accuracy	Sample accuracy is dependent on sampling effectiveness, flow measurement and calibration. Sampling effectiveness is expressed as the ratio of the mass concentration of particles of a given size reaching the sample filter to the mass concentration of particles of the same size approaching the sampler. The particle size for 50 percent effectiveness is required to be 10 ± 1 micrometers.	5.0 sampling effectiveness 10 ± 0.5 um 8.2.2 Flow rate accuracy of PM10 sampler: Part 58

Parameter	Method P	40CFR 50 Appendix M
5.1 PM10 sampler shall have	a. draw air sampler, via reduced internal pressure, into the sampler inlet and through the filter at a uniform face velocity b. hold and seal the filter in horizontal position so that sample air drawn downward through the filter c. allow the filter to be installed and removed conveniently d. protect the filter and sampler from precipitation and prevent insect and other debris from being sampled e. minimize leaks f. discharge exhaust air…. g. minimize the collection…. h. provide uniform distribution …	Section 7.1.1 Identical
5.2 Sampling effectiveness at wind speeds of 2 to 24 km/hr	Liquid particles ± 10% of that predicted by ideal sampler Solid particles, expected mass concentration no m ore than 5% above that obtained for liquid particles 50% cutpoint **10** ± **1** um aerodynamic diameter **Reproducibility 15% coefficient of variation for three collocated samplers** Wind speed 2 to 24 kph	Part 53.40 Table D-1 Expected mass conc. is the same For solids, the same **10** ± **0.5** um (above) **Precision (above**) Wind speed 2 to 24 kph (the same)
5.2 sampler flow rate and inlet	The sampler shall operate at a controlled flow rate specified by its designed or manufacturer, and it shall have an inlet system that provides particle size discrimination characteristics meeting all of the specifications in this document. The sampler inlet shall show no significant wind direction dependence. This requirement can generally be satisfied by an inlet shape that is circularly symmetrical about a vertical axis**.**	7.1.2 Identical
5.3 Total flow control	5.3 The sampler shall provide a means to measure the total flow rate during the sampling period. A continuous flow recorder is recommended. The sampler may be equipped with additional flow measurement devices if it is designed to collect more than one particle size fraction.	7.1.4 Identical
5.4 Automatic flow control	5.4 The sampler shall have an automatic flow control device capable of adjusting and maintaining the sample flow rate within **±10** percent for the sampler inlet over normal variations in line voltage and filter pressure drop. A convenient means must be provided to temporarily disable the automatic flow control device to allow calibration of the sampler's flow measurement device.	7.1.3 The sampler shall have automatic flow control device capable of adjusting and maintaining the sample flow rate within the flow rate limits specified for the sampler inlet Table D-1 Part 53.41; The

		average flow rate over 24 hours within ± **5%** of initial flow rate; all measured flow rates over 24 hours within ±10% of initial flow rate
5.5 A timing/control device	5.5 A timing/control device capable of starting and stopping the sampler shall be used to obtain an elapsed rune time of 24 ± 1 hr (1440 ± 60 minutes). An elapsed time meter, accurate within 15 minutes, shall be used to measure sampling time.	7.1.5 Identical
5.6 Manual	5.6 The sampler shall have an associated operational or instructional manual	7.1.6 Identical
6. Filters		7.2 Filters
6.1 Filter medium	6.1 No commercially available filter medium is ideal for all respect for all samplers The user's goal in sampling determine the relative importance of various filter evaluation criteria (e.g. cost, ease of handling, physical and chemical characteristics, etc.)	7.2.1 Identical
6.2 Collection Efficiency	6.2 Greater than 99 percent as measured by DOP test (ASTM-2986) with 0.3 um particles as the sampler's operating face velocity	7.2.2 Identical
6.3 Integrity	6.3 Integrity ± 5 ug/m3 (assuming sampler's nominal 24-hour air sample volume) measured as the concentration equivalent corresponding to the difference between the initial and final weights of the filter when weighed and handled under simulated sampling conditions (equilibration, initial weighing, placement on inoperative sampler, removal from sampler, re-equilibration, and final weighing)	7.2.3 Identical
6.4 Alkalinity	6.4 Alkalinity < 0.005 milliequivalent/gram (< 5 microequivalent/gram) of filter as measured by ASTM-D202 following at least two months of storage at ambient temperature and relative humidity	7.24 Alkalinity < 2.5 microequivalent/gram
7 Procedure	7.1 The sampler shall operate in accordance with the specific guidance provided in the sampler manufacturer's instruction manual. This procedure assumes that the sampler's flow rate calibration was performed using flow rates at ambient conditions (Qa)	9.0 Identical
7.2 Filter inspection	7.2 Inspect each filter for pinholes, particles, and other imperfections; establish a filter information record and assign an identification number to each filter. Careful handling of filters between preweighing and post-sampling is necessary to avoid errors due to damaged filters or loss of particulate.	9.2 identical
7.3 Filter equilibration	7.3 Equilibrate each filter in the conditioning environment for at least 24 hours. Environmental. temperature range: 15 to 30^{o}C, b. Temperature control: $\underline{+}$3^{o}C , and c. humidity: less than 50 percent relative humidity RH < 50 percent	9.3 For 24-hour 15 to 30C, ± 3C temperature control, humidity range 20% to 45%,humidity control ± 5% RH
7.4 Filter weighing etc.	7.4 Following equilibration, weigh each filter and record the presampling weight with the filter identification number.	9.4 Identical
7.5 Analytical Balance	7.5 The analytical balance must be suitable for weighing the type and size of filters required by the sampler. The range and sensitivity required will depend on the filter tare weight and mass loading. Typically, an analytical balance with a sensitivity of 0.1 mg is required for high volume SSI samplers (flow rates > 0.5 m^3/min)	7.5 Identical, also includes sensitivity of 0.1 mg for <u>low volume samplers</u> (flow rate < 0.5 m3/min)

Parameter	Method P	40CFR 50 Appendix M
7.6 Pre-Run Procedure	a. Air Sample Report – Prior to each run, record on the Air Sample Report: the reporting agency, station address, station name, instrument number and county, site, agency, and project codes.	9.9 Identical
	b. Clean Filter Installation – the clean particulate filter is placed on the sampler and secured in place.	9.5
	c. Flow Setting – The actual flow rate must be maintained as specified by the manufacturer in order to maintain the 10 µm cutpoint of the inlet. This will require special care at elevations greater than 1000 feet above sea level in order to prevent errors due to reduced atmospheric density	8.2.4 and 9.6 manufacturer's manual
	d. Elapsed Time Meter – Record the initial elapsed time meter reading on the Monthly Check Sheet.	9.8
7.7 Post-Run Procedure	a Final Flow Meter Reading – Before removing the filter and flow chart, make sure that the recorder trace shows the final flow. If not, the sampler must be started to determine the final flow. Remove the flow chart from the recorder and examine the trace for abnormalities. Note and investigate any abrupt changes in air flow. If the start and finish air flows are not representative of your geographic area, note this on the Air Sample Report under "Remarks".	9.11 and part of 9.6
	b Exposed Filter Removal – Grasp the exposed filter without toughing the darkened area. Fold it in half width-wise with the darkened side in. A satisfactory filter is one which has a uniform white border. Dark streaks into the border may indicate an air leak, which invalidates the sample. If there are insects on the filter, remove them carefully. Note on the Air Sample Report if the filter is torn or ruptured, if the start or finish times are not known, or if the flows are outside the specified range. Note: A removable filter cartridge may be loaded and unloaded at the station operator's headquarters to avoid contamination and damage to the filter media.	9.12 manufacturer's manual
7.7 Post-Run	c. Timer and Elapsed Time Meter Check – After each run, check how long the sampler ran by reading the elapsed time meter. Record the final elapsed time meter (ETM) reading. These ETM readings are used in calculating the concentration of collected particulates as they are more accurate than the time or flow chart times. Adjust the timers to meet the timer acceptance limits of 24 hours $\pm$ 15 minutes .	9.11. and part of 7.1.5
7.8 Equilibration	Equilibrate the exposed filter(s) in the conditioning environment for 24 hours and immediately after equilibration reweigh the filter(s) and record the weight(s) with filter identification number(s).	9.16 and 9.17: Identical (al least 24 hours)
		9.10 Sample for 24 $\pm$ 1h r
		9.14 Record any factors such as meteorological conditions, construction activity, fires or dust storms, etc. that might be pertinent to the measurement on the filter information record
		9.15 Transport the exposed filters to the filter conditioning

		environment as soon as possible
Parameter	**Method P**	**40CFR 50 Appendix M**
8.Calibration	*Calibrated using an **orifice transfer** standard that has been standardized against a primary standard root s meter *The orifice standard is referenced to 25C and 760 mm Hg. *Two types of orifice standard: **multihole** adapter plates to vary the flow and an **adjustable flow** restrictor. In both, the calibrator is connected to a differential pressure gauge or slack tube manometer. *Pressure drops and indicated flow meter readings are recorded and corrected for elevation, as necessary. *Using the pressure drops, the standard (true) flow rates are calculated using the certified equation for the transfer standard. Finally a working sampler calibration curve of standard flow rate vs indicated flow rate is plotted. **Assumptions:** Elevation below 1000 feet is equivalent to standard conditions The effect of temperature on the indicator flowrate is negligible and therefore is not used in the determination of the standard flow rate.	8.0
8.1 Apparatus		
	a-1 A flow rate transfer standard, suitable for the flow rate of the sampler and calibrated against a primary standard that is traceable to NBS, must be used to calibrate the sampler's flow measurement device.	7.3
	a-2 The reproducibility and resolution of the transfer standard must be 2 percent or less of the sampler's operating flow rate	8.2.2
	a-3. The flow rate transfer standard must include a means to vary the sampler flow rate during calibration of the sampler's flow measurement device.	
	b- 0-20" differential pressure gauge or slack tube manometer	
	c- Tygon tubing for static pressure connections	
	d- Faceplate adapter with "C" clamps **.**	
	e- Flow charts for continuous recorder	
	f- Calibration report forms	
	g- Plastic cap for constant volume sampler sensor	

Parameter	Method P	40CFR 50 Appendix M
8.2 "As Is" Calibration	Other than routine daily checks, sampler repairs or adjustments (brush changes, motor replacement, flow recorder changes, etc.) should not be made prior to the "as is" calibration. The sampler should be calibrated after each 800 hours (nearly 33 days) of operations, if the sampler is moved to a different site, or if the initial flow meter reading falls outside of specified tolerance limits. Note: Some samplers use a closed loop control system to provide constant blower speed and and sampler flow. The flow sensor is located in the throat of the filter holder assembly. Before calibrating this type of sampler, first cover the flow sensor with a plastic cap. After calibrating, remove the cap	
	8.2a Open the PM10 sampler shelters and remove the filter holder. Secure the faceplate adapter and orifice calibrator; then, tighten down the orifice calibrator. If using a variable resistance calibrator, simply secure the calibrator to the faceplate adapter and turn the restrictor control fully counterclockwise so that the maximum flow will be obtained. Connect a section of tygon tubing from the orifice tap on the calibrator to one leg of the manometer. Open the other leg so that it is open to the atmosphere. A schematic diagram of a typical sampler flow calibration is shown in Figure P-2.	
	8.2b After the sampler has warmed up, turn the motor off and then on and allow the static pressure (ÎP) and indicated flow reading (Qing) to stabilize. Then, read the static pressure (ΔP) and indicated flow readings (Qind). The static pressure is read as the total displacement, in inches, of the manometer water column. Record the static pressure and the indicated flow readings on the PM10 Sampler Calibration Data Sheet (see Figure P-4 as an example). Repeat this step twice so that a total of three test runs are performed.	
	8.2c Repeat Step b for each of the remaining four load plates. When using the variable resistance calibrator, select four additional points equally spaced around the setpoint determined in Section 7.6 (two points above and tow points below; see example in Figure P-4).	
	8.2d Remove the orifice calibrator from the sampler. Measure the indicated flow with a clean filter installed in the PM10 sampler and record this value on the bottom of the calibration data sheet	
	8.2e On the left side of the calibration data sheet, sum the ΔP readings for each line (runs 1-3) and record the sum under the sum ΔP for each line (points 1-5). Etc.	
	8.2f Record the elevation of the sampler on the calibration data sheet. If elevation less than 1,000 ft, no correction is required. If the elevation is 1000 ft or grater, apply an altitude correction factor.	
	8.2g Referring to the certification of equation and using the corrected ΔP values calculated in f, above, determine the record Qsts 9transfer standard) for each point, where Qstd = factor Corr ΔP	
	8.2h Using the data from the calibration data sheet, plot a calibration graph Qstd vs. Qind. Draw a straight line through the plotted points, or, or obtain a linear regression plot. This line represents the working sampler calibration graph for the particular sampler elevation.	

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	8.2i Using the tabulate values of the average Qind, determine Qperv (PM10 sampler) by referring to the pervious sampler calibration curve (Qstd vs Qind). Find the appropriate value of Qprev from the Y-axis corresponding to Qind on the x-axis.	
	8.2j Sum the column Qstd (transfer standard), tabulated on the left side of the calibration data sheet. Record this sum as "S1"	
	8.2k Sum the column Qprev (PM10 sampler), determine in Step I; record this sum as 'S2".	
	8.2l Calculate the percent deviation from the previous calibration using the equation listed on the bottom the calibration data sheet. Record the result.	
	8.2m Using the sampler calibration graph, convert the clean filter indicated air flow rate to standard air flow rate and record the result on the bottom the calibration data sheet.	
	8.2n Complete a Calibration Report (see Figure P-3). A copy should be kept at the sampling site and in the operating organization's headquarters file.	
8.3 "Final" Calibration	A final calibration is required after specified maintenance is performed (brush changes, motor replacement, flow recorder changes), including maintenance to correct the average initial flow meter reading being out of tolerance, or to repeat a sampler calibration graph which is non-linear.	
8.4 Blank Form and Assistance	Blank Forms and Assistance – a sample copy of forms such as blank Calibration Data Sheets, as well as assistance in calibration procedures, can be obtained by contacting: STATE OF CALIFORNIA Air Resources Board Aerometric Data Division Quality Assurance Section P.O. Box 2815 Sacramento, CA 95812	
9. Calculations	9.1 Determine the average flow rate over the sampling period corrected to reference conditions as Q_{std}.	11.
	9.2 9.2 Calculate the total volume of air sampled as: $v = Q_{std} \times t$ where: v = total air sampled in standard volume units, std m^3; t = sampling time, min.	11.1
	9.3 9.3 Calculate the PM10 concentration as: $PM10 = \frac{(w_f - w_I) \times 10^6}{v}$ Where: PM10 = mass concentration of PM10, Fg/std m^3; W_f W_I = final and initial weights of filter(s) Collecting PM10 particles, g; 10^6 = conversion of g to µg.	11.2